

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Woody Tang, et. al
Assignee: Mosel Vitelic, Inc.
Title: Methods of Reducing or Removing Micromasking Residue Prior to Metal Etch Using Oxide Hardmask
Application No.: 10/649,099 Filing Date: 08/26/2003
Examiner: Dahimene, Mahmoud Group Art Unit: 1765
Docket No.: M-12977 US Confirm: 4957

San Jose, California

VIA EFS-WEB
COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, VA 22313-1450

**DECLARATION OF HARKI SINGH
Pursuant to 37 CFR 1.131 Corroborating Date of
Actual Reduction to Practice**

Dear Sir:

I, Harki Singh, declare as follows:

1. I am not a named co-inventor of the invention described in the above-identified patent application.

2. I am currently an employee of Mosel-Vitellic Corp. (MVC) and have been continuously employed by it or by its predecessor, Mosel-Vitellic Inc. (MVI, the Assignee of record) continuously back to at least the dates (redacted dates) of the events described here for attached Exhibits A and B where the redacted dates all precede June 20, 2003 (the U.S. filing date of the Doshita 2003/0235987 prior art reference, which date is hereafter also referred to as the "critical art date"). My job title at MVC is Senior Process Engineer. I have worked as an engineer for more than 20 years, including at Ashland Chemical, Read Rite Disk Drives, and MVI/MVC. I have a B.S. in Chemistry from the University of Delhi, Delhi, India.

LAW OFFICES OF
MacPherson, Kwok, Chen &
Heid LLP

2033 Gateway Place
Suite 400
San Jose, CA 95110
Telephone: (408)-392-9520
Facsimile: (408)-392-9262

Accordingly I am well qualified to provide the below testimony regarding witnessing and understanding of the subject invention disclosure.

3. Inventor Woody Tang no longer works at MVC although one of his co-inventors George Kovall still does and I did converse with George Kovall regarding this matter. George read and reviewed this declaration of mine.

4. My involvement with the present invention is two fold.

5. First, I was a signing-corroborating witness (witness number 2 on page A.6 of Exhibit A) to the Invention Disclosure Form of which a true copy is attached hereto as **Exhibit A** with dates redacted (blacked out). The version that I witnessed did not contain the receipt stamp on page A.1 by law firm Skjerven Morrill, or the file number (M-12977) or the Exhibit A page numbers: A.1 through A.9.

6. Secondly, I was personally present at an in-house confidential presentation at MVI where Woody Tang presented experimental results including those showing actual reduction to practice of the invention disclosed (as I am given to understand) in the above-identified patent application. (I did not personally read the above-identified patent application and instead accept George Kovall's assurances to me that it is for the same "method to prevent metal etch micromasking residue" recited as the descriptive title on page A.1 of Exhibit A. Copies of selected slide pages from Woody Tang's presentation are attached hereto as **Exhibit B** with dates redacted (blacked out) therefrom. The whole of the presentation is not included here because many of the pages are irrelevant to the "method to prevent metal etch micromasking residue" invention being described here. It is to be understood that the MVI facility where I worked with the co-inventors and the current MVC facility where I still work with George Kovall has numerous commercial semiconductor production machines including lithography and metal etch reactors, as well as scanning electron microscope (SEM). As such,

9. Referring to page B.4 of Exhibit B, this shows the results of one particular test wafer identified as number WF 724-25 which had been produced without use a so-called "sputter-etch" residue removing process corresponding to the one described in Exhibit A (Invention Disclosure Form). The photomicrographs in page B.4 are merely showing comparison between results at the center of the wafer and the edge. It is to be noted that the oxide floor below the etched metal lines in the edge micrograph is not free of oxide bumps. Although an actual line-shortening metal bump is not caught in these micrographs (because actual shorts are rare anomalies), it is understood that the oxide floor bumpiness or roughness is attributed to pre-etch microresidue and the latter increases the danger of metal bumps being left behind which could lead to undesired inter-line shorting.

10. Referring to page B.5 of Exhibit B, this shows the comparison results between a first post metal-etch wafer (Wf 724(784)-25) where the residue minimizing "sputter etch" had not been performed and a second post metal-etch wafer (Wf 724(784)-22) where the residue minimizing "sputter etch" had been performed. While it is hard to tell from photocopies of the original micrographs, the oxide floor below the etched metal lines of wafer Wf 724(784)-22 (right side) is relatively free of oxide bumps (free of roughness) that is associated with possible micromasked metal residue and possible inter-line shorting by such micromasked metal while the oxide floor below the etched metal lines of wafer Wf 724(784)-25 (left side) exhibited observable oxide bumps (roughness, see also page B.4) that is associated with possible metal residue being left behind and possible inter-line shorting due to pre-etch micromasking.

11. Still referring to page B.5, to the best of my recollection, the inventors used the coined term, "sputter etch" to refer to a two-fold etch process that precedes actual metal etch where the "sputter etch" process included chemical etch attack on micromasking residue as well as anisotropic bombardment (with Argon) of the residue to physically sputter it away;

much of the work is done in-house. Some esoteric metrology results might be farmed out though to outside metrology specialists though because our metrology capabilities are limited.

7. Referring to Exhibit B, this confidential MVI in-house presentation happened prior to the event of Exhibit A and therefore I shall describe my recollection of the Exhibit B presentation first. The redacted date on the bottom right of each page in Exhibit B precedes the critical art date (6/20/2003) and the former redacted date is the date on which, to the best of my good faith belief and recollection, the presentation took place. Woody Tang and his co-inventors (Yi Ding and George Kovall) had been working on a complex metal etch process that had been developing in-house where the metal etch process had many more components than just the issue of reducing micromasking residue. The actual presentation of Exhibit B was substantially longer and more complex. The content of the redacted pages of Exhibit B were obtained from an MVI database where such process module presentations are stored as a normal course of business. Referring to page B.2 of Exhibit B, this is an outline of the full presentation. However, in order to limit this discussion to the relevant subject matter, namely, the process for minimizing micromasking residue, only a selected number of pages from the presentation are presented here as Exhibit B, pages B.1-B.5.

8. Referring to page B.3 of Exhibit B, the first full paragraph denoted as "1)" demonstrates (at least to my satisfaction as a skilled artisan) that the inventors had reached several milestones including that of minimizing the stated "ultra micro masking effect". Paragraph "5)" of page B.3 demonstrates that the inventors felt that this particular metal etch process was ready for use in mass production. In other words, they relayed to me and other technical staff attending the MVI process module presentation with objective evidence that successful reduction to practice had been achieved at least with regard to minimizing the stated "ultra micro masking effect".

hence the two terms: sputter and etch. The title of page B.5, "Comparison with and without pre-sputter etch" refers to the experimental comparison results between wafers Wf 724(784)-25 (left side) and Wf 724(784)-22 (right side) and demonstrates improved removal of micromasking residue in the right side results. To the best of my current recollection, the inventors had explained to us on the redacted date of the presentation that they had reduced to actual process a recipe which included both chemical etch attack and mechanical sputter attack on micromasking residue prior to final metal etch in order to reduce tiny oxide and/or metal bumps from being left behind on the oxide floor after the final metal etch. Thus, as a corroborating witness, I am convinced that the inventors had reduced their invention of how to eradicate the micromasking residue to actual practice and had demonstrated that it works for its intended purpose prior to the critical art date.

12. Referring to Exhibit A, (the redacted Invention Disclosure Form), my signature testifying to having read and understood this invention disclosure appears on witness page A.6 between witness one (top) and the reviewing department head. The redacted date of witnessing both for myself and co-witness Karen Wong (same date) is prior to the critical art date (prior to June 20, 2003).

13. On page A.5 (the one bearing the signatures of the three inventors), the last full paragraph discloses that the metal etch recipe is a chlorine based etch step with appropriate additional conditions added to assure efficient sputter-enhanced etching of the surface in order to reduce residue. My understanding at the time in reading and witnessing this invention disclosure form (Exhibit A) is that it is for the same micro masking residue removal invention earlier presented to us in Exhibit B by Woody Tang et al. Page A.8 corresponds to page B.5. I am given to understand that page A.7 corresponds to a page in Woody's invention notebook and the recipe for wafer number Wf 724(784)-22 appears on the bottom of that page.

14. In view of the attached corroborating evidence and based on my recollection, it is my good faith belief that the inventors had fully conceptualized the invention as well as reduced it to actual practice with regard to removing micromasking residue using a chlorine based etch process that further included sputter bombardment (e.g., with Argon) so as to substantially remove micromasking residue prior to final metal etch of an aluminum stack. It is my understanding (although I have not read the patent application) that this same residue-removing "sputter etch" process is disclosed and claimed in the above-identified application.

15. All statements made herein of my own knowledge are true, all statements made herein on information and belief are believed to be true, and all statements made herein are made with the knowledge that whoever, in any matter within the jurisdiction of the Patent and Trademark Office, knowingly and willfully falsifies, conceals, or covers up by any trick, scheme, or device a material fact, or makes any false, fictitious or fraudulent statements or representations, or makes or uses any false writing or document knowing the same to contain any false, fictitious or fraudulent statement or entry, shall be subject to the penalties set forth under 18 U.S.C. 1001, and that violations of this paragraph may jeopardize the validity of this patent application, or the validity or enforceability of any patent or certificate resulting therefrom.

Signature: Harkishan Singh Date: 5/30/2008
Harki Singh

LAW OFFICES OF
MacPherson, Kwok, Chen &
Heid LLP

2033 Gateway Place
Suite 400
San Jose, CA 95110
Telephone: (408)-392-9520
Facsimile: (408)-392-9262